

REMARKS

Claims 4-7, 13-14 and 17-18 are pending in the application. Claims 4-5, 13-14 and 18 are herein amended. No new matter has been added.

Amendments

The amendments redefine the value of b in the formula $Ca_aA^{1-b}Co_cA^{2-d}O_e$ recited in Claims 4 and 13, and in the formula $Ca_aA^{1-b}Co_cA^{2-d}O_e$ recited in Claims 5 and 14, to the range of $0.3 \leq b \leq 0.8$. Examples 1 to 35, 48 to 82, 95 to 97, 101 to 103, 107 to 109, 113 to 115, and 119 to 120 of the present specification disclose electrically conductive pastes containing the oxides represented by the formulae above. In these Examples, oxides wherein the value of b is 0.3 or more are used, demonstrating the effectiveness of these oxides. The amendments define the lower limit value of the range of values of b based on these Examples.

Rejections under 35 USC §102(b)

Claim 1 was rejected under 35 USC §102(b) as being anticipated by Matsubara et al. (Matsubara et al., “Fabrication of an all-oxide thermoelectric power generator,” Applied Physics Letters Vol. 78 (2001): 3627-3629).

Claim 1 has been cancelled. Thus, the rejection has become moot.

Rejections under 35 USC §103(a)

Claims 1-7 were rejected under 35 USC §103(a) as being obvious over Alexander (U.S. Patent No. 5,422,190) combined with Matsubara et al. (Matsubara et al., “Fabrication

of an All-Oxide Thermoelectric Power Generator,” Applied Physics Letters Vol. 78 (2001): 3627-3629).

Claims 1-3 have been cancelled. Thus, the rejection of claims 1-3 has become moot.

Claims 4 to 7 are directed to an electrically conductive paste for connecting a p-type thermoelectric material comprising (i) at least one specific powdery oxide selected from the specified group and (ii) at least one powdery electrically conductive metal selected from the group consisting of gold, silver, platinum, and alloys containing at least one of these metals.

By preparing a thermoelectric element using this paste for connecting a thermoelectric material, it becomes possible, to impart a suitable electrical conductivity to the connecting portion of the thermoelectric element. Because separation at the connecting portion barely appear even after repeated high-temperature power generation, thermoelectric performance will be maintained over a long period of time.

Alexander cited in the previous Office Action discloses a via fill paste for use in the construction of electronic circuit devices. This paste is aimed at solving the problem of connecting a layer of conductive silver to a layer of conductive gold. Alexander discloses “a via fill paste comprising gold, silver, palladium, and a refractory oxide” as a paste suited to this purpose. In Alexander, however, oxides contain metals such as zirconium, yttrium ... and lutetium as refractory oxides, and nothing in Alexander teaches or suggests the specific oxides as recited in Claim 4.

The Examiner cited Matsubara et al. for teaching a thermoelectric p-type oxide represented by $\text{Ca}_3\text{Co}_4\text{Co}_9$ in the abstract, and alleged that this oxide matches the material recited

in the present Claim 4. The oxide of Matsubara, however, is used as p-type legs, and has nothing to do with materials used for connecting oxides.

In the Advisory Action, the Examiner asserted that the addition of a metal to any oxide to provide electrical conductivity is known. As discussed previously, however, Alexander simply discloses a paste comprising specific proportions of gold, silver, palladium, and refractory oxide that is capable of solving the prior art problem described in the “BACKGROUND” section in column 1, and particularly the problem of connecting a layer of conductive gold and a layer of conductive silver. Alexander does not teach or suggest the addition of a metal to an oxide to provide electrical conductivity.

Matsubara et al., on the other hand, discloses using a Pt paste and a Pt wire when a p-type material and an n-type material are connected, but is silent as to a paste containing an oxide. In the Advisory Action, the Examiner asserted that the use of a metal oxide in thermoelectric structures is known and that it is also known that this oxide has electrical conductivity. However, even if the oxide used as a thermoelectric material has electrical conductivity, the oxide used in the paste disclosed in Alexander is indicated as a refractory oxide, which does not require electrical conductivity. Accordingly, there is no reason to use the specific oxide of Matsubara et al., which is merely used as p-type legs, as an oxide for use in the paste of Alexander.

It would not be obvious from the combination of the above-mentioned references that the paste comprising the specific oxide used in the present invention not only imparts a suitable electrical conductivity to the connecting portion, but also enables thermoelectric performance to

be maintained without causing separation at the connecting portion even after repeated use as the thermoelectric material at high temperatures.

Moreover, the claims have been amended to redefine the value of b in the formula $Ca_aA^1_bCo_cA^2_dO_e$ to be in the range of $0.3 \leq b \leq 0.8$. Accordingly, the oxide represented by this formula now comprises A^1 as a constituent element, and thus, is clearly distinguished from $Ca_3Co_4Co_9$. Furthermore, the previous Amendment amended the phrase concerning A^1 to read “one or more elements selected from the group consisting of Na, K, Li, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Pb, Sr Ba, Al, and Bi,” hence, the oxide represented by the formula $Ca_aA^1_bCo_cA^2_dO_e$ recited in Claim 4 is distinguished from $Ca_3Gd_{0.25}Co_4O_9$ disclosed in Matsubara et al.

Thus, Matsubara et al. fails to disclose the complex oxide contained in the paste of the present Claim 4.

Accordingly, even if Alexander and Matsubara et al. were combined, it would not have been obvious to attain the paste of the present invention which essentially requires a specific complex oxide that is not disclosed in any of these references.

As described above, there is no logical reason to combine Alexander and Matsubara et al. Further, the powdery oxide recited in the amended Claim 4 is not disclosed in any of these references.

For at least the same reasons, Claim 4 patentably distinguishes over Alexander and Matsubara et al. Claims 5 to 7, which depend on Claim 4, also patentably distinguish over Alexander and Matsubara et al. for at least the same reasons.

Claims 8-11 were rejected under 35 USC §103(a) as being obvious over Alexander (U.S. Patent No. 5,422,190) combined with Funahashi et al. (JP Abstract Publication number 2003-282964).

Claims 8-11 have been cancelled. Thus, this rejection has become moot.

Claims 12-14 were rejected under 35 USC §103(a) as being obvious over Alexander (U.S. Patent No. 5,422,190) combined with Matsubara et al. (Matsubara et al., “Fabrication of an all-oxide thermoelectric power generator,” Applied Physics Letters Vol. 78 (2001): 3627-3629) and Funahashi et al. (JP Abstract Publication number 2003-282964).

Claim 12 has been cancelled. Thus, the rejection of claim 12 has become moot.

Funahashi discloses a complex oxide having high Seebeck coefficient and high electric conductivity. Funahashi discusses nothing about connecting material. Thus, Funahashi does not remedy the deficiencies of Alexander and Matsubara et al.

Claims 13 and 14 are directed to thermoelectric elements wherein one end of a p-type thermoelectric material and one end of an n-type thermoelectric material are respectively connected to an electrically conductive substrate with an electrically conductive paste.

Claim 13 specifically defines the compositions of the p-type and n-type thermoelectric materials, and a paste of the same composition as that of Claim 4 is used for connecting the p-type thermoelectric material. Claim 14 also recites that a paste of the same composition recited in Claim 5 is used for connecting the p-type thermoelectric material.

As stated above, Claims 13 and 14 relate to thermoelectric elements. In addition to the types of the thermoelectric materials, the p-type thermoelectric material is connected to an electrically conductive substrate with the electrically conductive paste for connecting a thermoelectric material recited in Claim 4 or 5.

As stated above, the conductive pastes for connecting a p-type thermoelectric material recited in Claims 4 and 5 patentably distinguish over the combination of Alexander and Matsubara et al.

For at least these reasons, claims 13 and 14 patentably distinguish over Alexander, Matsubara and Funahashi.

Claims 15 and 16 were rejected under 35 USC §103(a) as being obvious over Alexander (U.S. Patent No. 5,422,190) combined with Matsubara et al. (Matsubara et al., “Fabrication of an all-oxide thermoelectric power generator,” Applied Physics Letters Vol. 78 (2001): 3627-3629) and Funahashi et al. (JP Abstract Publication number 2003-282964) as applied to claim 12 above, and further in view of Buist (U.S. Patent No. 4,859,250).

Claims 15 and 16 have been cancelled. Thus, this rejection has become moot.

Claims 17 and 18 were rejected under 35 USC §103(a) as being obvious over Alexander (U.S. Patent No. 5,422,190) combined with Matsubara et al. (Matsubara et al., “Fabrication of an all-oxide thermoelectric power generator.” Applied Physics Letters Vol.

78 (2001): 3627-3629) and Funahashi et al. (JP Abstract Publication number 2003-282964) as applied to claim 13 above, and further in view of Buist (U.S. Patent No. 4,859,250).

Claim 17 is directed to a thermoelectric module comprising a plurality of the thermoelectric elements of claim 13, and claim 18 is directed to a thermoelectric conversion method using the module.

With regard to these claims, the Examiner cites Buist (U.S.P. No. 4,859,250), in addition to the aforementioned references. Buist discloses, in Fig. 3a, a device in which the elements are connected in a similar manner to that defined in claim 17. Buist also discloses, in Fig. 4, a method for power generation using a positioning process similar to that defined in claim 18.

Claim 17, however, further recites a plurality of the thermoelectric elements of claim 13. As discussed above, claim 13 patentably distinguishes over any combination of the aforementioned references. Buist does not remedy the deficiencies of Alexander, Matsubara and Funahashi.

For at least these reasons, claim 17 patentably distinguishes over Alexander, Matsubara, Funahashi and Buist. Claim 18, directed to a method using the module of claim 17, also patentably distinguish over Alexander, Matsubara, Funahashi and Buist for at least the same reasons.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact the undersigned attorney at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

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Art Unit: 1795

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If this paper is not timely filed, Applicant respectfully petitions for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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